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EXAMINER	
HUANG, DAVID S	
ART UNIT	**PAPER NUMBER**
2611	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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Office Action Summary	Application No.	Applicant(s)
	10/770,116	GEORGIOS ET AL.
	Examiner	**Art Unit**
	DAVID HUANG	2611

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _30 January 2008_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-44_ is/are pending in the application.

4a) Of the above claim(s) _31_ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-30 and 32-44_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _02 February 2004_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant’s arguments, with respect to the declaration have been fully considered and are persuasive. The objection of 11/01/2007 has been withdrawn.

2. Applicant’s arguments, with respect to claims 34-39, and 41 have been fully considered and are persuasive. The objection of 11/01/2007 has been withdrawn.

3. Applicant’s arguments, with respect to claim 33 have been fully considered and are persuasive. The 35 U.S.C. 112, 2nd paragraph rejection of 11/01/2007 has been withdrawn.

4. Applicant's arguments with respect to claims 1-30, 32-42 have been considered but are not persuasive.

Applicant's argument: Claims 1, 17, 30 and 42 require a multi-dimensional beamformer that generates a plurality of differently coded data streams from a single stream of symbols and that adjust a power allocation to each of the differently coded data streams, wherein the multi-dimensional beamformer forms blocks of symbols from the single stream of symbols and then encodes each of the blocks differently to generate the differently coded data stream. Neither Ling nor Onggosanusi, disclose or suggest at least these claim elements.

Examiner's response: While Ling admittedly does not disclose a "multi-dimensional beamformer," Ling does disclose a plurality of differently coded data streams from a single stream of symbols, forming blocks of symbols from the single stream of symbols, as can be seen in Fig. 3 (page 4, [0053]-[0055], [0059]). Onggosanusi overcomes the deficiencies in Ling in the single-user multi-stream transmitter shown in Fig. 22 (page 12, [0157]). Transmitter 800 provides a plurality of single stream transmitter each with a separate data stream input that has

power allocation applied at the respective mixers (Fig. 22; see also Fig. 1, transmit power allocator 26). One of ordinary skill in the art would have been able to take the blocks of symbols generated by Ling as the input data streams of the multi-stream transmitter of Onggosanusi. This would have been obvious since it would provide space-time beamformer technology which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Applicant's argument: Claims 5 and 25 require that a beamformer comprise a space-time block coder that processes the single stream of symbols from the constellation selector by forming blocks of symbols from the single stream of symbols and then space-time coding each of the blocks differently.

Examiner's response: In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

As explained above, Ling provides the teaching for forming blocks of symbols from the single stream of symbols. The other cited references provide the teaching for space-time block coding, as applied below.

Applicant's argument: Claim 3 requires that the constellation selector select the signal constellation based, at least in part, on channel mean feedback received from a second wireless communication device when producing the signal stream of symbols. Onggosanusi and Ling both fail to disclose or suggest the elements recited in claim 3, as amended.

Examiner's response: In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

In this case, Visotsky et al. teaches channel mean feedback. See rejection of claims 3 and 32 below.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. **Claims 1, 2, 4, 14, 17, 18, 21, 23, 24, 30, 33, 40, and 42** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US 2002/0191703) in view of Onggosanusi et al. (US 2002/0114269).

Regarding **claims 1, 17, and 30**, Ling et al. disclose a wireless communication device comprising:

a plurality of adaptive modulators (TX data processor 114a-114k, Figure 4) to process respective streams of information bits (channel data stream, page 6, [0065]), wherein each adaptive modulator comprises:

(i) a constellation selector (symbol mapping element 208, Figure 2A) that adaptively selects a signal constellation from a set of constellations based on channel state information for a wireless communication channel, wherein the constellation

selector maps the respective information bits to symbols drawn from the selected constellation to produce a single stream of symbols (Page 4, [0039]); and

(ii) a MIMO processor (120c, Figure 3) that generates a plurality of differently coded data streams (V_1-V_T, Figure 3) from the single stream of symbols wherein the multi-dimensional beamformer forms blocks of symbols from the single stream of symbols and then encodes each of the blocks differently to generate the differently coded data streams (DEMUX 310, and rest of 120c, Fig. 3; page 5, [0054]-[0055], [0059]); and

a modulator (122a to 122t, Figure 3) to produce a multi-carrier output waveform in accordance with the plurality of coded data streams (for transmission through the wireless communication channel (page 6, [0060]-[0061], Figure 3).

However, Ling et al. fail to expressly disclose (I) a multi-dimensional beamformer that generates a plurality of differently coded data streams from the single data stream of symbols and adjusts a power allocation to each of the differently coded data streams.

Onggosanusi et al. disclose single stream transmitter (10) module 18 coupled to channel state processing unit 16, which additional incorporates sub-channel selection circuitry 24 containing beamformer weight determiner 30. The set of beamformer weights are passed on to the single stream transmitter module 18. The modulated signal stream is weighted by the corresponding value from the weight vector (page 3, [0043], [0045]; Figures 1 and 2). Fig. 22 shows a single-user multi-stream transmitter (page 2, [0036]) 800 that includes a plurality of signal stream transmitter modules 820, and a plurality of antennas 830. The transmitter 800 operates in a manner similar to transmitter 10 (including transmit power allocation weights

applied to respective mixers from channel state processing unit 810) (Fig. 22). Each of the single stream tx modules 820 receives a different weighted data stream (Fig. 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination of Ling et al. with the multi-stream transmitter comprised of single stream transmitter modules and beamformer weight determiner as taught by Onggosanusi et al. since it would provide space-time beamformer technology which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Regarding **claim 2**, Ling et al. disclose everything claimed as applied above (see *claim 1*), and further disclose wherein the constellation selector selects the signal constellation based at least in part on partial information (SNR) for the wireless communication channel (page 4, [0039]).

Regarding **claim 4**, Ling et al. disclose everything claimed as applied above (see *claim 1*), and further disclose wherein the constellation selector selects the signal constellation based at least in part on a target throughput (bit rate matches transmission capability, page 11, [0134]).

Regarding **claim 14**, Ling et al. discloses everything claimed as applied above (see *claim 1*), but fail to expressly disclose wherein the beamformer is a two-dimensional beamformer that generates the plurality of coded data streams as two orthogonal data streams.

Onggosanusi et al. disclose multiple single stream transmitter modules 18 could be coupled in parallel. Each single stream transmitter module 18 would receive its own frequency index and set of beamformer weights corresponding to the unique sub-channel selected and receive a unique data stream for transmission (page 3, [0044]; Figure 1). Onggosanusi et al. also provides an example of such an transmitter (Fig. 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination of Ling et al. and Onggosanusi et al. with multiple (two) single stream transmitter modules since it is suggested by Onggosanusi et al. as being readily apparent to one skilled in the art (page 3, [0044]).

Regarding **claim 18**, Ling et al. disclose everything claimed as applied above (see *claim 17*), and further disclose a plurality of transmit antennas that output the multi-carrier waveform (antennas 124a to 124t, Figure 3, page 6, [0062]).

Regarding **claim 21**, Ling et al. disclose everything claimed as applied above (see *claim 17*), and further disclose wherein the constellation selectors (symbol mapping element 208, Figure 2A) of the adaptive modulators load additional information bits within the streams of information bits to indicate the selected constellations (the number of information bits that may be transmitted for each modulation symbol is dependent on the SNR of the transmission channel, Page 4, [0039]).

Regarding **claim 23**, Ling et al. disclose everything claimed as applied above (see *claim 17*), and further disclose wherein the adaptive modulators (symbol mapping element 208, Figure 2A) jointly perform power and bit loading across the streams of information bits (page 4, [0039]; groups sets of coded bits to form non-binary symbols, and maps the non-binary symbols into points in a signal constellation corresponding to a particular modulation scheme selected for that transmission channel, and the number of information bits that may be transmitted for each modulation symbol is dependent on the SNR of the transmission channel).

Regarding **claim 24**, Ling et al. disclose everything claimed as applied above (see *claim 17*), and further disclose wherein the constellation selectors of the adaptive modulators select the

signal constellation for the respective stream of information bits based on partial information (SNR) for the wireless communication channel (page 4, [0039]).

Regarding **claim 33**, Ling et al. disclose everything claimed as applied above (see *claim 30*), and further disclose wherein coding signals comprises forming Eigen-beams based on the channel state information (eigenmodes are derived and applied, page 5, [0055]).

Regarding **claim 40**, Ling et al disclose everything claimed as applied above (see *claim 30*), and further disclose the steps:

adaptively selecting a signal constellation from a set of constellations for each sub-carrier of a multi-carrier wireless communication system (each frequency subchannel, page 6, [0066]);

generating an outbound streams for each sub-carrier based on the selected constellations (V_1-V_T, Page 5, [0059], Figure 3); and

applying modulators (122, Figure 3) to each of the coded data streams to produce multi-carrier output waveforms for transmission through the multi-carrier wireless communication channel (page 6, [0060]-[0061]).

However, Ling et al. fail to expressly disclose the step of applying an eigen-beamformer to each of the streams of symbols to generate a plurality of coded data streams.

Onggosanusi et al. teach disclose single stream transmitter module 18 coupled to channel state processing unit 16, which additional incorporates sub-channel selection circuitry 24 containing beamformer weight determiner 30. The set of beamformer weights are passed on to the single stream transmitter module 18. The modulated signal stream is weighted by the corresponding value from the weight vector (page 3, [0043], [0045]; Figures 1 and 2). Onggosanusi et al. also disclose matrix H, which represents the overall channel (page 5, [0062]).

The specific orthogonal vectors corresponding to the non-interfering sub-channels can be determined by computing the value of the signal value decomposition of matrix H. The resulting inherently orthogonal eigenvectors can then be used to derive the set of appropriate weights for forming the necessary beamformer vectors for transmitting and receiving signals via the orthogonal sub-channels (page 5, [0066]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Ling et al. with the teaching of Onggosanusi et al. because it would facilitate space-time beamformer technology, which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Regarding **claim 42**, Ling et al. disclose a computer-readable medium encoded with computer executable instructions for causing a programmable processor (page 12, [0143]) of a wireless communication device to:

receive channel state information for a wireless communication system (full or partial CSI reported by the receiver system, page 5, [0053]);

select a signal constellation from a set of constellations based on the channel state information (modulation adjusted based on available CSI, on Page 5, [0052]-[0053]);

map information bits of an outbound data stream to symbols drawn from the selected constellation to produce a single stream of symbols (page 6, [0065]); and

producing a plurality of code signals for transmitting over a wireless communication channel (MIMO-OFDM, page 6, [0065]; implicit that OFDM is implemented in a wireless communications system, page 1, [0004]), wherein the multi-dimensional beamformer forms blocks of symbols from the single stream of symbols and then encodes each of the blocks

differently to generate the differently coded data streams (DEMUX 310, and rest of 120c, Fig. 3; page 5, [0054]-[0055], [0059]).

However, Ling et al. fail to expressly disclose applying an eigen-beamformer to generate a plurality of coded data streams from the stream of symbols to produce a plurality of coded signals.

Onggosanusi et al. disclose a single stream transmitter module 18 coupled to channel state processing unit 16, which additional incorporates sub-channel selection circuitry 24 containing beamformer weight determiner 30. The set of beamformer weights are passed on to the single stream transmitter module 18. The modulated signal stream is weighted by the corresponding value from the weight vector (page 3, [0043], [0045]; Figures 1 and 2). Onggosanusi et al. also disclose matrix H, which represents the overall channel (page 5, [0062]). The specific orthogonal vectors corresponding to the non-interfering sub-channels can be determined by computing the value of the singular value decomposition of matrix H. The resulting inherently orthogonal eigenvectors can then be used to derive the set of appropriate weights for forming the necessary beamformer vectors for transmitting and receiving signals via the orthogonal sub-channels (page 5, [0066]). Fig. 22 shows a single-user multi-stream transmitter (page 2, [0036]) 800 that includes a plurality of signal stream transmitter modules 820, and a plurality of antennas 830. The transmitter 800 operates in a manner similar to transmitter 10 (including transmit power allocation weights applied to respective mixers from channel state processing unit 810) (Fig. 22). Each of the single stream tx modules 820 receives a different weighted data stream (Fig. 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination of Ling et al. with the multi-stream transmitter comprised of single stream transmitter modules and beamformer weight determiner as taught by Onggosanusi et al. since it would provide space-time beamformer technology which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

7. **Claims 3, 32, and 44** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) as applied to claim 1 above, and further in view of Visotsky et al. (NPL – *Space-Time Transmit Precoding with Imperfect Feedback*, September 2001).

Regarding **claims 3 and 32,** the combination of Ling et al. and Onggosanusi et al. discloses everything claimed as applied above (see *claim 1*), but fails to expressly disclose wherein the constellation selector selects the signal constellation based at least in part on channel mean feedback received from a second wireless communication device when producing the single stream of symbols that is then used by the multi-dimensional beamformer to generate the differently coded data streams.

Nevertheless, Ling et al. teach TX data processor 114 generates modulation symbols and that the coding and modulation may be adjusted based on available full or partial CSI reported by the receiver system (page 5, [0053], Fig. 3).

Visotsky et al. discloses two feedback schemes mean feedback and covariance feedback (Page 2633, Part B). For transmit antenna arrays, the gain through even partial knowledge of the channel can be substantial. For mean feedback, the beamforming strategy performs close to the

optimal strategy when the feedback is of reasonable quality. The beamforming strategy performs close to the optimal strategy for covariance feedback when there is a strong path present which can be exploited by the beamforming. Overall, the beamforming strategy appears to be a viable transmission strategy when meaningful feedback is present (page 2637, Section V, 1st paragraph).

Because both Visotsky et al. and the combination of Ling et al. and Onggosanusi et al. disclose feedback schemes, it would have been obvious to one of ordinary skill in the art to substitute one feedback scheme for the other for the obvious result of providing mean feedback of reasonable quality.

Regarding **claim 44**, the combination of Ling et al. and Onggosanusi et al. discloses everything claimed as applied above (see *claim 1*), but fails to expressly disclose wherein the multi-dimensional beamformer adjusts the power allocation to each of the differently coded data streams based at least in part on channel mean feedback received from a second wireless communication device.

Nevertheless, Ling et al. disclose channel state information is reported back to the transmitter system to adjust signal processing and high performance is achieved based on the determined channel conditions (page 1, [0009]-[0011]).

Onggosanusi et al. also disclose each single stream transmitter 10 (Fig. 1), includes channel state processing unit 16, which incorporates transmit power allocator 26. The power amplification factor is determined by the transmit power allocator 26 as part of the channel state processing unit 16 (page 3, [0042],[0043], Fig. 1).

Thus, the combination of Ling et al. and Onggosanusi et al. teach using CSI fed back from a receiver to control power allocation. This would have been obvious to one of ordinary skill in the art since using CSI to adjust signal processing achieves high performance.

Visotsky et al. discloses two feedback schemes mean feedback and covariance feedback (Page 2633, Part B). For transmit antenna arrays, the gain through even partial knowledge of the channel can be substantial. For mean feedback, the beamforming strategy performs close to the optimal strategy when the feedback is of reasonable quality. The beamforming strategy performs close to the optimal strategy for covariance feedback when there is a strong path present which can be exploited by the beamforming. Overall, the beamforming strategy appears to be a viable transmission strategy when meaningful feedback is present (page 2637, Section V, 1st paragraph).

Because both Visotsky et al. and the combination of Ling et al. and Onggosanusi et al. disclose feedback schemes, it would have been obvious to one of ordinary skill in the art to substitute one feedback scheme for the other for the obvious result of providing mean feedback of reasonable quality.

8. **Claims 5-8, 10-13, 16, 25-27, 29, 34-36, 38, 39, and 41** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) as applied to claim 1 above, and further in view of Dabak et al. (US Patent 6,594,473).

Regarding **claims 5 and 25**, Ling et al. disclose everything claimed as applied above (see *claims 1 and 17*), but fail to explicitly disclose wherein the beamformer (of each of the adaptive modulators) comprises a space-time block coder that processes the stream of symbols from the

constellation selector by forming the blocks of symbols from the single stream of symbols and then space-time coding each of the blocks differently to generate the plurality of differently coded data streams as a plurality of space-time block coded data streams.

Nevertheless, Ling et al. does disclose DEMUX 210 forms subchannel symbol streams from the modulation symbols from the TX Data processor 114 (Fig. 3). The streams are provided to respective subchannel MIMO processors 312, which generates preconditioned modulation symbols (page 5, [0054]-[0055]; Fig. 3).

Dabak et al. discloses open and closed loop encoder 60 which may be included within a transmitter such as transmitter 42 (Figure 4). Open loop diversity is depicted in Figure 2, as providing space time block coded transmit antenna diversity (STTD) (column 5, lines 46-52; Figure 2). Encoder 60 has an input 62, which by way of example is shown to receive a first symbol S1 at a time T follow by a second symbol S2 at a time 2T, and again assume by way of example that symbols S_1 and S_2 are QPSK symbols. Encoder 60 has two outputs 64_1 and 64_2, each connected to a respective antenna $A60_1$ and $A60_2$ (column 13, lines 35-43; Figure 5). This teaching is advantageous because instances may arise where a transmitter in a closed loop diversity system receives feedback from a receiver to develop weights for future transmissions, but due to some factor (e.g., high Doppler), the transmitter is informed of some reduced amount of confidence in the weights. A combined diversity system can be created by adding an open loop diversity technique (STTD) to the closed loop system (column 13, lines 24-33).

Therefore it would have been obvious to one of ordinary skill in the art, at the time the invention was made to provide Ling et al. with the encoder taught by Dabak et al. since open

loop systems provide greater performance in a high Doppler environment (column 6, lines 38-41).

Regarding **claim 6**, the combination applied to *claim 5* further discloses in Dabak et al. wherein the space-time block coder processes the stream of symbols to generate the plurality of differently coded data streams N space-time block coded data streams, where N equals the number of transmit antennas (column 13, lines 42-43, see Figure 5).

Regarding **claim 7**, Ling et al. disclose everything claimed as applied above (see *claim 5*), but fails to expressly disclose wherein the beamformer comprises a power splitter that adjusts the power allocation to each of the differently coded data streams to control a total power allocated across the space-time block coded data streams.

Onggosanusi et al. disclose transmit power allocator 26 (Figure 1), coupled to channel state information estimator 20. The signal strength of the stream of data 12 has been modulated by a power amplification factor determined by the transmit power allocator 26 as part of the channel state processing unit 16 (page 3, [0042]-[0043]). This teaching is advantageous since for a fixed total transmitted power, there is a trade-off between throughput and BER (page 9, [0112]), and the power allocator 26 can be used to balance throughput and BER according to a desired performance level.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide Ling et al. with the transmit power allocator taught by Onggosanusi et al. because it would allow the system to balance achieving high throughput with sufficiently low BER.

Regarding **claim 8**, the combination applied to *claim 7* further discloses in Onggosanusi et al. wherein the power splitter adjusts the power allocation to the space-time block coded streams based at least in part on the channel information (transmit power allocator 26 coupled to channel state information estimator 20).

Regarding **claim 10**, Ling et al. disclose everything claimed as applied above (see claim 7), but fail to expressly disclose wherein the power splitter adjusts the power allocation of the data streams to maximize the transmission rate while maintaining a target bit error rate (BER).

Onggosanusi et al. disclose a strategy to maximize the instantaneous throughput fro a given worst-case BER requirement (page 9, [0115]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combination applied to *claim 7* to balance maximizing throughput with low BER as taught by Onggosanusi et al. since a maintaining a minimum BER ensures proper transmission and reception of the information stream, whereas coding may not be able to correct of overly high BER.

Regarding **claim 11**, the combination of Ling et al. and Onggosanusi et al. discloses everything claimed as applied above (see *claim 7*), and Onggosanusi et al. further disclose wherein the beamformer applies an antenna weighting vector to the space-time coded data streams to allocate a portion of each of the space-time coded data streams to each of the output antennas (page 3, [0045]).

Regarding **claim 12**, the combination of Ling et al. and Onggosanusi et al. discloses everything claimed as applied above (see *claim 11*), but fails to expressly disclose wherein the

beamformer adaptively adjusts the antenna weighting vector based on the channel state information.

Onggosanusi et al. further teach in connection with selecting a sub-channel, a frequency index is selected and a corresponding set of beamformer weights are determined, both of which are respectively identified by a frequency index selector 29 and a beamformer weight determiner 30. The sub-channels are typically selected based upon the sub-channel having preferred signaling characteristics as determined through an analysis of the channel state information (page 3, [0043]; Figure 1). These are contained in the sub-channel selection circuit 24, which is coupled to the channel state information estimator 20, which identifies a set of available orthogonal sub-channels within the channel space by analyzing the inherent gain associated with each signal path between each of a set of one or more transmit antennas 14 and each of a set of one or more corresponding receive antennas 22, as shown in Figure 4 (page 3, [0042], Figure 1).

Therefore it would have been obvious to one of ordinary skill in the art to modify the combination of applied to claim 11 to adjust the antenna weighting vector based on the channel state information since by carefully computing or selecting the sets of values from which the beamformer vector and the frequency index are selected, substantially orthogonal and/or non-interfering sub-channels can be defined (page 3, [0041]). This facilitates space-time beamformer technology, which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Regarding **claim 13**, Ling et al. discloses everything claimed as applied above (see *claim 12*), but fails to expressly disclose wherein the antenna weighting vector comprises an eigen vector of a correlation matrix representative of the channel state information.

Onggosanusi et al. disclose matrix H, which represents the overall channel (page 5, [0062]). The specific orthogonal vectors corresponding to the non-interfering sub-channels can be determined by computing the value of the signal value decomposition of matrix H. The resulting inherently orthogonal eigenvectors can then be used to derive the set of appropriate weights for forming the necessary beamformer vectors for transmitting and receiving signals via the orthogonal sub-channels (page 5, [0066]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combination applied in claim 12 with the teaching of Onggosanusi et al. because the analysis of the matrix H determines the number of orthogonal space-time dimensions, which correspond to the number of available non-interfering sub-channels (page 5, [0062]). This facilitates space-time beamformer technology, which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Regarding **claims 16 and 29**, Ling et al. disclose everything claimed as applied above (see *claims 1 and 17*), but fail to explicitly disclose wherein the wireless communication device comprises a base station.

However, it is well known in the art to implement a transmitter with multiple antennas as a base station as is evidenced by Dabak et al. (column 8, lines 18-31, Figure 4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to implement the wireless communication device as a base station since it is well known in the art.

Regarding **claim 26**, Ling et al. disclose everything claimed as applied to *claim 25*, and further disclose wherein the beamformer of each of the adaptive modulators comprises a power

splitter that controls a total power allocated across the space-time block coded data streams based on the channel information.

Onggosanusi et al. disclose transmit power allocator 26 (Figure 1), coupled to channel state information estimator 20 (i.e., 26 receives channel state information from 20). The single stream transmitter module 18 additionally receives a stream of data 12, after the signal strength of the stream of data 12 has been modulated by a power amplification factor. The power amplification factor is determined by the transmit power allocator 26 as part of the channel state processing unit 16 (page 3, [0042]-[0043]). This teaching is advantageous since for a fixed total transmitted power, there is a trade-off between throughput and BER (page 9, [0112]). Thus, the power allocator 26 can be used to balance throughput and BER according to a desired performance level.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide Ling et al. with the transmit power allocator coupled to channel state information estimator taught by Onggosanusi et al. because they would allow the system to balance achieving high throughput with sufficiently low BER.

Regarding **claim 27**, the combination of Ling et al., Onggosanusi et al. and Dabak et al. discloses everything claimed as applied above (see *claim 25*), and Onggosanusi et al. further disclose wherein the beamformer of each of the adaptive modulators applies an antenna weighting vector to the space-time coded data streams based on the channel state information to allocate a portion of each of the space-time coded data streams to each of the output antennas. (page 3, [0045]).

Regarding **claim 34**, Ling et al disclose everything claimed as applied to *claim 30*, but fail to expressly disclose wherein coding signals comprises processing the stream of symbols from the constellation selector to generate space-time block coded data streams.

Dabak et al. discloses open and closed loop encoder 60 which may be included within a transmitter such as transmitter 42 (Figure 4). Open loop diversity is depicted in Figure 2, as providing space time block coded transmit antenna diversity (STTD) (column 5, lines 46-52; Figure 2). Encoder 60 has an input 62, which by way of example is shown to receive a first symbol S1 at a time T follow by a second symbol S2 at a time 2T, and again assume by way of example that symbols S_1 and S_2 are QPSK symbols. Encoder 60 has two outputs 64_1 and 64_2, each connected to a respective antenna $A60_1$ and $A60_2$ (column 13, lines 35-43; Figure 5). This teaching is advantageous because instances may arise where a transmitter in a closed loop diversity system receives feedback from a receiver to develop weights for future transmissions, but due to some facto (e.g., high Doppler), the transmitter is informed of some reduced amount of confidence in the weights. A combined diversity system can be created by adding an open loop diversity technique (STTD) to the closed loop system (column 13, lines 24-33).

Therefore it would have been obvious to one of ordinary skill in the art, at the time the invention was made to provide Ling et al. with the encoder taught by Dabak et al. since the open loop system provides greater performance in a high Doppler environment (column 6, lines 38-41).

Regarding **claim 35**, Ling et al. disclose everything claimed as applied to *claim 34*, but fail to expressly disclose the step of applying a power splitter within the beamformer to control a total power allocated across the space-time block coded data streams.

Onggosanusi et al. disclose transmit power allocator 26 (Figure 1), coupled to channel state information estimator 20. The single stream transmitter module 18 additionally receives a stream of data 12, after the signal strength of the stream of data 12 has been modulated by a power amplification factor. The power amplification factor is determined by the transmit power allocator 26 as part of the channel state processing unit 16 (page 3, [0042]-[0043]). This teaching is advantageous since for a fixed total transmitted power, there is a trade-off between throughput and BER (page 9, [0112]). Thus, the power allocator 26 can be used to balance throughput and BER according to a desired performance level.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide Ling et al. with the transmit power allocator taught by Onggosanusi et al. because it would allow the system to balance achieving high throughput with sufficiently low BER.

Regarding **claim 36**, the combination applied to *claim 35* further discloses in Onggosanusi et al. adjusting the power allocation to the space-time block coded streams based at least in part on the channel information (transmit power allocator 26 coupled to channel state information estimator 20).

Regarding **claim 38**, the combination applied to *claim 35* fails to disclose the step of applying an antenna weighting vector to the space-time coded data streams to allocate a portion of each of the space-time coded data streams to each of the multiple antennas.

Onggosanusi et al. disclose the modulated signal stream is coupled to each of the transmit antennas after being appropriately weighted by the corresponding value from the weight vector. Where multiple single stream transmitter modules 18 are used, each of the weighted signal

streams for a particular antenna 14 are summed together before being coupled to the corresponding antenna 14 (page 3, [0045]; see Figures 1 and 2).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination applied to claim 35 with the step of weighting as taught by Onggosanusi et al. because it would facilitate space-time beamformer technology which accounts for inter-symbol interference and is used to enhance signal transmissions (page 1, [0011]).

Regarding **claim 39**, the combination applied to *claim 38* fail to explicitly disclose the step of adjusting the antenna weighting vector based on the channel state information.

However it is implicit from Onggosanusi et al.'s disclosure that beamformer weight determiner 30 adjusts weights based on channel state information since sub-channel selection circuitry 24, which contains beamformer weight determiner 30, is coupled to the channel state information estimator 20. Sub-channels are selected based upon the sub-channel having preferred signaling characteristics as determined through an analysis of the channel state information. In connection with selecting a sub-channel, a corresponding set of beamformer weights are determined (page 3, [0042]-[0043]; Figure 1).

Regarding **claim 41**, Ling et al. disclose everything claimed as applied above (see *claim 35*), but fail to expressly disclose adaptively selecting a signal constellation for each subcarrier based on the power allocated to each subcarrier.

Onggosanusi et al. teach throughput is maximized by using all the N_{dim} spatio-temporal dimensions for data transmission as discussed above. However, for a fixed total transmitted power, this comes at the expense of BER since the power has to be distributed between N_{dim}

streams. Hence there is a trade-off between throughput and BER. Throughput may be traded for lower BER by choosing to transmit with $M< N_{dim}$ data streams. Since perfect CSI is available at the transmitter, the sub-channel gains (eigenvalues) can be determined (page 9, [0112]). The most power efficient way to achieve a relative throughput of M is to use the M sub-channels with the highest gains (page 9, [0013]). Since the sub-channel gains are determined based on CSI, the power allocation is also based on CSI.

Therefore, it would have been obvious to one of ordinary skill in the art to adaptively select a signal constellation based on the power allocated since there is a tradeoff between throughput and BER, and in order to maintain a minimum BER for a fixed total transmitted power, throughput may be reduced by choosing a lower modulation level.

9. **Claims 9 and 37** rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) and Dabak et al. (US Patent 6,594,473) as applied to *claims 8 and 35* above, and further in view of Sampath (US Patent Application Publication 2003/0043929).

Regarding **claim 9**, the combination applied to *claim 8* fails to expressly disclose wherein the power splitter adaptively adjusts allocation of total power across the space-time coded data streams as a function of the constellation that is selected by the constellation selector.

Sampath teaches if a first symbol stream includes a higher transmission order (higher order QAM) than a second symbol stream, the preprocessor can allocate more power to the first stream and less power to the second stream (page 5, [0069]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combination applied to *claim 8* so that the power allocation is based on the chosen modulation order as taught by Sampath since input symbol streams can be scaled in this way to maximize the minimum distance between coded symbol streams.

Regarding **claim 37**, the combination applied to *claim 35* fails to expressly disclose the step of adaptively adjusting allocation of total power across the space-time coded data streams as a function of the selected constellation.

Sampath teaches if a first symbol stream includes a higher transmission order (higher order QAM) than a second symbol stream, the preprocessor can allocate more power to the first stream and less power to the second stream (page 5, [0069]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combination applied to *claim 8* so that the power allocation is based on the chosen modulation order as taught by Sampath since input symbol streams can be scaled in this way to maximize the minimum distance between coded symbol streams.

10. **Claims 15 and 28** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) as applied to *claims 1 and 17* above, and further in view of Hockley, Jr. et al. (US Patent Application Publication 2004/0008138).

Regarding **claims 15 and 28**, Ling et al. disclose everything claimed as applied above (see claims 1 and 17), but fail to explicitly disclose wherein the wireless communication device comprises a mobile phone.

Hockley, Jr. et al. disclose a mobile device 110 and although one antenna 210 is shown, a mobile device may implement more than one antenna (page 4, [0045], Figure 2). Furthermore, Hockley, Jr. et al. disclose the mobile device is a cellular phone (page 3, [0032]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to specify the multiple antenna invention of Ling et al. to be a cellular phone since Hockley, Jr. et al. teach that a cellular phone or other mobile device may implement more than one antenna where each antenna may operate in a distinct frequency spectrum, or the multiple antennas may operate in overlapping frequency spectrums (page 4, [0045]).

11. **Claims 19 and 20** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) as applied to *claim 17* above, and further in view of Heo et al. (US Patent Application Publication 2003/0103481).

Regarding **claim 19**, Ling et al. disclose everything claimed as applied above (see *claim 17*), but fail to expressly disclose wherein each adaptive modulator further comprises: a power loader that processes the respective stream of information bits and loads additional information bits indicative of a power allocated to the respective stream of information bits,

wherein the respective constellation selector adaptively selects the signal constellation based on based on the additional information bits.

Heo et al. discloses a control information generator for generating control information inserting at least one bit indicating a modulation order used for transmission of the spread packet among the a plurality of available modulation orders into one information field in the control information (Page 3, [0027]). The base station determines the modulation order to be used for

transmission of packet data and generates control information indicating the determined values based on forward radio channel quality information of the selected mobile station and the transmission power allocated for the packet data service (Page 4, [0047]).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide Ling et al. with the control information generator taught by Heo et al. since inserting modulation order information aids in the decoding of data by enabling a mobile station to determine a modulation order used by a base station without using a separate mapping table (page 2, [0024]).

Regarding **claim 20**, the combination applied to *claim 19* further teaches-in Heo et al.- wherein the power loader of the adaptive modulators loads the additional information bits based on the channel state information (forward radio channel quality information, Page 4, [0047]).

12. **Claim 22** is rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US Patent Application Publication 2002/0191703) in view of Onggosanusi et al. (US Patent Application Publication 2002/0114269) as applied to *claim 21* above, and further in view of Hughes-Hartogs (US Patent 4,731,816).

Regarding **claim 22**, Ling et al. disclose everything claimed as applied above (see claim 21), but fail to expressly disclose wherein the constellation selectors of the adaptive modulators insert the additional bits by determining which of the streams of information bits are able to support each of the additional bits with the least required additional power.

Hughes-Hartogs discloses a power allocation system that computes the marginal required power to increase the symbol rate on each carrier from n to n+1 information units. The system then allocates information units to the carrier that requires the least additional power to increase

its symbol rate by one information unit. Because the marginal powers are dependent on the values of the equivalent noise spectrum of the particular established transmission link, the allocation of power and data is specifically tailored to compensate for noise over this particular link (column 3, lines 4-16).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the symbol mapping element of Ling et al. with the power allocation system of Hughes-Hartogs since the resultant allocation of power and data would be tailored to compensate for noise over a particular link.

13. **Claim 43** is rejected under 35 U.S.C. 103(a) as being unpatentable over Ling et al. (US 2002/0191703) in view of Onggosanusi et al. (US 2002/0114269) as applied to claim 1 above, and further in view of Hottinen et al. (US 2005/0078761).

Regarding **claim 43**, Ling et al. disclose everything claimed as applied to claim 1, but fail to expressly disclose wherein the beamformer comprises a two-dimensional beamformer that produces two different Alamouti coded data streams that are power loaded and transmitted along two orthogonal basis beams.

Onggosanusi et al. disclose multiple single stream transmitter modules 18 could be coupled in parallel. Each single stream transmitter module 18 would receive its own frequency index and set of beamformer weights corresponding to the unique sub-channel selected and receive a unique data stream for transmission (page 3, [0044]; Figure 1). The inherently orthogonal eigenvectors can then be used to derive the set of appropriate weights for forming the necessary beamformer vectors for transmitting and receiving signals via the orthogonal sub-channels (page 5, [0066]). Power amplification factor is determined by the transmit power

allocator for each single stream transmitter, and thus, each sub-channel (page 3, [0043]-[0044]). Onggosanusi et al. also provides an example of such an transmitter (Fig. 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination of Ling et al. and Onggosanusi et al. with multiple (two) single stream transmitter modules since it is suggested by Onggosanusi et al. as being readily apparent to one skilled in the art (page 3, [0044]).

However, Ling et al. and Onggosanusi et al. fail to disclose the two different coded data streams are Alamouti coded data streams.

The Alamouti transmit diversity solution is well known in the art, as is evidenced by Hottinen et al. (page 1, [0005]). The Alamouti scheme is called a 2 by 2 space-time block code, as it employs two transmit beams during two symbol periods (page 1, [0005]-[0006]; equation 1). The orthogonality of the Alamouti matrix enables separate decoding of the two symbols transmitted, in such a way that the symbols do not interfere with each other (page 1, [0006]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the combination of Ling et al. and Onggosanusi et al. with the well known Alamouti space-time block code, since it is specially suited to transmit 2 beams (2-dimensional) and enables separate decoding of the two transmitted symbols so that they do not interfere with each other which thereby improving the quality of the received signal (Hottinen et al., page 1, [0004]).

Citation of Pertinent Prior Art

14. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Wallace et al. (US 6,473,467) discloses obtaining CSI feedback (Fig. 1b) and using it to generate a plurality of differently encoded data streams (Fig. 3).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David Huang whose telephone number is (571) 270-1798. The examiner can normally be reached on Monday - Friday, 8:00 a.m. - 5:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shuwang Liu can be reached on (571) 272-3036. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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